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Opportunities for Electrical Efficiency in the Meat Processing Industry

Report No 90-346-K

A.T. Chow
Engineer
Utilization Section
Electrical Research Department

ABSTRACT

A survey of meat processors in Ontario assessed their level of interest in employing energy efficient technologies, and identified opportunities for reducing electrical consumption. This report contains the information collected from the survey, and the recommendations for implementing the electrical efficiency improvements identified in this project. These opportunities are (1) efficient lighting in cold room and freezers, (2) heat recovery for hot water and space heating, (3) better insulation in the cold spaces, (4) load shifting electric water heaters to reduce maximum demand, and (5) electric stimulation of beef to reduce refrigerated aging time. With about 100 meat packers in the province, the total potential electrical demand reduction is estimated at **480 kW** and **2,550 MWh** each year.

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TABLE OF CONTENTS

SUMMARY ii

RECOMMENDATIONS iii

INTRODUCTION 1

OPPORTUNITIES TO IMPROVE ENERGY EFFICIENCY 1

HEAT RECOVERY 2

LOAD SHIFTING 3

BETTER COLD SPACE INSULATION 3

EFFICIENT LIGHTING 4

ELECTRIC STIMULATION OF BEEF 4

BENEFITS TO THE CUSTOMER 5

BENEFITS TO ONTARIO HYDRO 6

ACKNOWLEDGEMENT 7

APPENDIX A. Summary of Survey Results 8

APPENDIX B. Meat Processing Industry Electricity End-Use Survey 13

APPENDIX C. Meat Processing Industry Electricity End-Use Survey Results 18

APPENDIX D. Estimating Energy Efficiency Benefits 20

DISTRIBUTION 21

SUMMARY

This project examined the potential of improving energy efficiency in the meat processing industry with the cooperation of the Ontario Independent Meat Packers and Processors Society. By surveying the members of the Society, the project assessed their level of interest in employing energy efficient technologies, and identified the opportunities for reducing electrical consumption. This report contains the information collected from the survey and the recommendations for implementing the electrical efficiency improvements identified in this project. The findings of this project include:

1. The opportunities for improving electrical efficiency include:

   (1) heat recovery from refrigeration compressors for hot water and space heating,
   (2) better insulation in the cold spaces to reduce refrigeration load,
   (3) load shifting electric water heaters to reduce maximum demand,
   (4) efficient lighting in cold spaces, and
   (5) electric stimulation of beef to reduce refrigerated aging time.

2. The independent meat processors are very interested in opportunities to improve electrical efficiency.

3. Working with the industry's association is an effective method to disseminate information and to stimulate customer participation in programs.

Most meat processors have electric hot water tanks, electric space heating, and refrigeration compressors. Their electric bill can be reduced by recovering rejected heat from refrigeration compressors for hot water production and for space heating. If electric water heaters are still needed, further demand reduction is possible by load shifting. Larger hot water tank capacity, either with additional tanks or a larger tank, can provide enough storage for off-peak operation of the electric heaters to reduce demand charges. Refrigeration load can be reduced by increasing the insulation, and by installing plastic curtains to the entrances of cold spaces. Energy efficient lighting consumes less electricity and emits less heat, thereby reducing electric load both for lighting and for refrigeration. Finally, for beef producers who also package their beef, electric stimulation can reduce the refrigerated aging storage time by 50%. With about 100 meat processors in Ontario, the total electrical load reduction is estimated at **480 kW** and electrical consumption can be reduced by an estimated **2,550 MWh** each year.

RECOMMENDATIONS

Significant electrical reduction is possible if a program is initiated to provide customers with information for efficiency improvement opportunities. This program includes:

1. **Technical Assistance**:

   Assistance to the customers can include:

   (1) energy audit,
   (2) metering of electrical load pattern,
   (3) contact with equipment manufacturers,
   (4) recommendations in customer-specific efficiency improvements,
   (5) incentive programs to make a technology more affordable (accelerated payback, etc), and
   (6) follow-up assistance to verify and to fine-tune savings.

2. **Success Story Collection**:

   The survey revealed a high level of interest in energy efficiency among the participants. The survey also discovered the numerous initiatives taken by individuals adopting energy efficient technology. When new opportunities are discovered through individual initiatives, disseminating their "success stories" will help other customers who could potentially benefit from it. Better circulation of the success stories would stimulate other customers to adopt the new methods for saving electricity.

3. **Industry Contacts**:

   Presence at industry seminars and exhibits allows valuable information to be distributed to the interested customers. The cooperation of industry associations, who organize trade shows, seminars, and exhibits, ensures that the most interested customers would be reached by the program.

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TO: MR. J.E. MITCHELL
Manager - Technical Services & Development Department
Program Support & Services Division
C25F6

Attn: Mr. P.K. Lee

Opportunities for Electrical Efficiency in the Meat Processing Industry

INTRODUCTION

The purpose of this project is to examine the potential of reducing electrical consumption in Ontario's meat processing industry. The project was carried out with the cooperation of the Ontario Independent Meat Packers and Processors Society. By surveying the members of the Society, this project assessed their level of interest in employing energy efficient technologies, and identified some opportunities for reducing electrical consumption. This report contains the information collected from the survey and the recommendations for implementing the electrical improvements identified in this project. In addition, the report also attempts to estimate the impact on Ontario's electrical demand and consumption due to implementing these improvements.

OPPORTUNITIES TO IMPROVE ENERGY EFFICIENCY

The opportunities for reducing electrical demand and energy consumption include:

(1) heat recovery from refrigeration for hot water and space heating,
(2) better insulation in the cold spaces,
(3) load shifting electric water heaters to reduce maximum demand,
(4) efficient lighting in cold spaces, and
(5) electric stimulation of beef to reduce refrigerated aging time.

Over 50% of the respondents are using electric hot water tanks and over one-third have electric space heating. Virtually all the respondents have refrigeration compressors. These customers' electric bills can be reduced by recovering rejected heat from refrigeration compressors for hot water and space heating. If the daily peak demand is causing demand charges to be added to the electric bill, load shifting can reduce demand charges. Load shifting is operating the electric heaters at night by using either an additional or a larger hot water tank to provide enough storage for daily use.

Refrigeration load can be reduced by increasing the insulation, and by installing curtains at the entrances to the cold spaces. Doing so will reduce heat loss by conduction through the walls and by air current

passing through opened doors. Energy efficient lighting consumes less electricity and emits less heat. Replacing incandescent light bulbs in the cold spaces with energy efficient fluorescent lights will reduce electric load both for lighting and for refrigeration.

For beef producers who also package their beef, electric stimulation can reduce the aging time or cooler space by 50%. Each of these opportunities is briefly described in the sections below.

The survey's responses show an uneven pattern of electrical utilization. About 25% of the surveys were returned. Since the number of responses is not a large portion of the population, it is possible that the responses are only from those customers who are more interested in energy efficiency, and those who are direct customers of Ontario Hydro. Nevertheless, some customers rely heavily on fossil-fuel for producing hot water and for space heating; others utilize electricity for most processes. Indeed, some customers undertook to adopt electrically efficient technologies while others did not. The diversity of the group represented by the survey's responses does not justify a generalized "average customer" in the statistical sense. Each customer's situation is unique and the solution for energy efficiency is a unique combination of different technologies. Those technologies with the most impact are described below. For the sake of illustration in the following sections, a hypothetical operation is used to find the "typical" reduction in electrical demand and consumption. This hypothetical operation is described in the section discussing **Benefits to the Customer**.

Appendix A contains a graphical summary of the survey's results. Appendix B is a copy of the survey. Appendix C describes the survey's results in more details. Appendix D contains the methods for estimating electrical reduction potential in a specific operation.

HEAT RECOVERY

Over 50% of the meat processors who responded to the survey have electric hot water tanks. Each electric hot water tank represents about 60 ipg of capacity and about 4 kW of electric demand. About one-third of the customers use propane, 13% use natural gas, and 9% use oil. Many customers use a combination of different fuels. For the 70% of all customers who use less than 300 ipg or 1360 L each day, the amount of energy needed for heating hot water is less than 130 kWh. At the same time, two out of three customers have over 5 tons of refrigeration capacity rejecting heat equivalent to more than 17 kW. Heat recovery can use this rejected heat to heat cold water to about 60°C or 140°F. Four of the meat processors in the survey indicate that heat recovery for making hot water is already saving money for them. It is estimated that most customers with electric hot water tanks can expect a reduction from 4 to 8 kW and from 20,000 to 40,000 kWh annually (or from $1,200 to $2,400 per year at $0.06/kWh).

A few customers, with hot water tank capacity over 245 ipg or 1,100 L, use on average 1,000 ipg or 4,500 L each day. These customers are likely to have refrigeration capacity between 20 and 50 tons. This combination of available heat and high water usage provides the largest opportunity.

Three of the meat processors, or 13% of the respondents, already use rejected heat from the refrigeration compressors to provide space heating. According to survey results, one-third of all meat processors have electric space heating. About 45% use propane. Oil is used by 13% of respondents. Only 9% use natural gas. Of all the respondents, 13% have mixed sources of energy for space heating. Unless the physical location of the refrigeration compressors prevents it, heat recovery would reduce energy cost regardless of the fuel used.

It is estimated that heat recovery both for producing hot water and for space heating can reduce about **300 kW** of electric demand and **1,000 MWh** of consumption each year in Ontario's meat processing industry.

LOAD SHIFTING

The hot water temperature produced through heat recovery depends on the discharge temperature of the refrigeration compressor. For most applications, heat recovery is sufficient to reduce electric consumption by over 80%. In some cases, the customer's electric bill can be reduced further by load shifting. Larger hot water tank capacity, either with additional tanks or a larger tank, can store all the required volume for each day by operating the heaters only at night to reduce demand charges. However, demand charges would be reduced only if the daily peak exceeds the customer's allowable limit. For general customers, the first 50 kW of demand is free. Nevertheless, the hot water tanks should be well insulated to reduce heat loss. A 60-gallon tank can lose about 1,300 kWh each year. This amounts to $78 at $0.06/kWh. Doubling the R-value of the insulation reduces this to less than 650 kWh, or $39 a year, a 50% saving.

Another demand reduction potential is in the operation of the refrigeration system. The survey indicates that one out of eight customers has refrigeration capacities over 20 tons. Not all of the available capacity may be required except for reducing an entire load of fresh meat to freezing temperatures. Some processors have holding rooms and freezing rooms where the cold meat and the fresh meat are cooled separately. When this is the case with more than one compressor, their combined demand can be minimized by operating one compressor at a time for intermittent intervals. This type of programmed operation can be implemented in many ways. One way is to use individual timers to allow each refrigeration compressor its own time-slot so that none would be operating simultaneously. This method is the simplest to install, but requires careful programming to ensure that the cold space temperature is maintained properly. Another method is to use a programmable controller with temperature sensors to operate the compressors. This method is more expensive but also more flexible. In any case, energy consumption and demand load can be reduced by using off-peak refrigeration "cold-storage". Cold-storage is similar to having a larger hot water storage capacity, except that cold water instead of hot water is stored at night. Although this technology is not yet widely adopted, its potential for load shifting warrants further investigation.

BETTER COLD SPACE INSULATION

The refrigeration load is a combination of cool-down load (reducing the temperature of fresh meat from about 90°F or 32°C to the cold room temperature), and make-up load (maintaining the cold space temperature and compensating for heat loss from conduction through the walls and ceilings, and from convection due to opened doors when transporting the meat into and out of the cold spaces). The make-up load can be reduced by using better insulation and better isolation. Better insulation reduces heat loss by conduction. Better cold-space isolation, using double doors and plastic curtains, reduces heat loss by convection. Over half the customers have refrigeration systems between 5 and 20 tons. About one-third have less than 5 tons. It is estimated that using R-35 instead of R-20 insulation for a cold room of about 2500 ft^2 or 232 m^2 can reduce electrical demand by 0.9 kW and electrical consumption by 7,700 kWh per year. The heat loss due to conduction alone costs about $460/yr at $0.06/kWh. Most meat processors have refrigeration capacity of about 13 tons or refrigeration compressor load of 15 kW, with annual electrical consumption of about 130,000 kWh each year. The total annual cost of refrigeration is about $7,800 at $0.06/kWh. Reducing the heat loss by improving insulation would reduce annual cost by about 6% for the "typical" customer. For beef producers who also package the meat, the refrigeration load can

be reduced further. This is discussed in more details in the section describing **Electric Stimulation of Beef**.

EFFICIENT LIGHTING

Energy efficient lighting not only consumes less electricity but also emits less heat. Replacing 60-W incandescent light bulbs with high efficiency fluorescent lights reduces electric lighting load by 46 W for each light bulb. Since each light bulb also emits heat into the cold-space, the replacement also reduces refrigeration load. Most commercial freezers and refrigeration systems have a "coefficient of performance" of about 3, which means that 1 kW of electricity can remove 3 kW of heat. So, a 60-W light bulb adds another 20 W to the refrigeration compressor load. Using fluorescent lights reduces the refrigeration load by a third of 46 W or about 15 W. The total electric load reduction is therefore: 46 W + 15 W = 61 W or 100% of the rating of the incandescent light being replaced. The survey indicates that although most lights are operated for only 10 to 12 hours, approximately one-third of the respondents operate the lights inside the cold spaces continuously. Door-activated-switches, occupancy sensors and timers can automatically turn off the lights when not needed. It is estimated that each continuously operating 60-W incandescent light costs $42 of electricity each year to operate. A 14-W fluorescent light operating 12 hours a day, on the other hand, costs about $5 a year. Replacing ten 60-W incandescent light bulbs with fluorescent lights operated automatically would reduce electrical consumption by 6,200 kWh every year (or $370 at $0.06/kWh).

ELECTRIC STIMULATION OF BEEF

Research Report 90-65-K indicated that electric stimulation of beef can reduce refrigeration load for three reasons: (1) faster chill time, (2) hot-boning, and (3) reduced aging time in the cooler. The survey confirmed that electric stimulation of beef can reduce aging time and consequently, cooler space and refrigeration needs. According to the experience of three meat processors who have been using electric stimulation, the aging time of beef in the cooler can be reduced from about 15 days to about 7 days. This represents a reduction of refrigeration load of 50%. About 60% of the customers de-bone and package beef. They can benefit from this technology to: (1) reduce electrical consumption, and (2) reduce cooler space requirement. The main obstacles in using electric stimulation seem to be: (1) the cost of adopting this technology, and (2) the lack of information available on the use and the benefits of electric stimulation. Over 75% of the responses indicate that electric stimulation of beef was never considered. Use of this technology can be increased if more information and incentive programs are available.

Using electric stimulation reduces refrigeration time by about 50%. The energy saving can be conservatively estimated by calculating the heat loss due to conduction through the walls. The energy consumption reduction is the refrigeration load reduction divided by the coefficient of performance of the refrigeration system. There are other factors which will add to the energy reduction. However, their complexity prevents further discussion at this time. It is estimated that heat loss reduction alone can reduce electrical consumption by about 9000 kWh for the typical customer with a cooler that is about 2500 ft^2 or 232 m^2 in area. This represents $540 in savings each year.

BENEFITS TO THE CUSTOMER

The recommendations in this report represent potential reduction in the operating cost of the meat processing customer. The cost saving is unique to each customer, and specific to the customer's equipment and operation. For the "typical" customer, the cost saving can be estimated using the procedure similar to that in Appendix D.

The cost benefits are summarized in **Table 1** for the "typical" operation with two electric hot water heaters of 60 ipg capacity each, and using 300 ipg each day for 290 days each year. The cold water temperature is assumed to be 60°F or 16°C. The total refrigeration capacity is 20 tons. Lighting in the cold spaces are provided by 10 light bulbs of 60 W each, operating continuously. The cold space has a floor area of about 2,500 ft^2 or 232 m^2, a ceiling of 10 ft or 3 m. The walls of the cold space have R-20 insulation throughout. Depending on the customer's total electric demand, and other fuel costs for hot water and space heating, there can be other savings due to lower demand charges and reduced consumption of fossil-fuel.

Table 1 - Estimated Cost Benefits to the Customer from Energy Efficiency Improvements

	kW reduction	kWh reduction each year	savings each year
Heat Recovery	6.0	19,500	$1,170
Load Shifting	-	-	-
Efficient Lighting	0.6	5,256	$ 315
Better Cold Space Insulation	0.9	7,700	$ 462
Electric Stimulation of Beef	1.0	9,000	$ 540
Total	8.6	41,500	$2,500

BENEFITS TO ONTARIO HYDRO

For Ontario Hydro, these energy efficiency improvements provide both tangible benefits in the form of demand and consumption reduction, as well as intangible benefits in the form of customer satisfaction. Over one-third of the responses showed a desire for consultation with or suggestions from Ontario Hydro. Some responses indicated average electric bills are over $1,000 per month. As shown in the previous section, these energy improvements can sometimes reduce a customer's electric bills by up to $200 per month or about 20%. For some customers, there is also the reduction in other fuel costs (such as propane and gas). This intangible benefit to Ontario Hydro means better customer and community relations.

The tangible benefits to Ontario Hydro are estimated in **Table 2**. These figures are calculated assuming the following percentages of customer participation: heat recovery 50%, efficient lighting 50%, improved insulation 100%, electric stimulation of beef 58%. The demand reduction is calculated from the percentage customer participation multiplied first by the estimated 100 meat processors in Ontario, and then by the demand reduction calculated for the "typical" operation described in the last section. These figures are, therefore, conservative estimates derived from the information obtained in the survey.

Table 2 - Estimated Benefits to Ontario Hydro from the Energy Efficiency Improvements

	kW reduction	kWh reduction
Heat Recovery	300	1,000,000
Load Shifting	-	-
Efficient Lighting	30	262,800
Better Cold Space Insulation	90	770,000
Electric Stimulation of Beef	58	522,000
Total	**480**	**2,550,000**

ACKNOWLEDGEMENT

The cooperation of Ms. Laurie Murdoch from the Ontario Independent Meat Packers and Processors Society made this survey possible. Her contributions are gratefully appreciated. Furthermore, Society members' participation in the survey is crucial to its chances of success. This report would not be possible without their participation.

Special thanks must go to Mr. Doug Lewis, from W.D. Lewis Meats Ltd., for his willingness to share his experience with energy efficient technologies. His special knowledge and his assistance make this report more relevant to those who are interested in improving energy efficiency.

Ms. Maureen Smith from Ontario Hydro's Guelph Area Office provided invaluable assistance in understanding customer billing procedures and records of electrical usage. The analysis of the survey's results would not be complete without her assistance.

Approved by:

A.F. Baljet
Manager
Electrical Research Department

Prepared by:

A.T. Chow
Engineer
Utilization Section

Reviewed by:

J.T. Strack
Unit Heat - Process Applications
Utilization Section

ATC:djb

APPENDIX A. Summary of Survey Results

This summary provides a quick graphical reference to the results of the survey. Twenty-four bar graphs summarize the responses to the multiple-choice questions in the survey. Each bar in the graph represents one of the alternatives in the multiple-choice question. The height of the bar represents the number of responses selecting the alternative indicated directly below the bar. The question is briefly described below each graph. The responses of the survey are summarized in five sections.

The first section gives an overview of the customers' operations. This includes: (1) the area code, (2) the electric utility, (3) the number of operating days each week, (4) the number of operating hours each day, (5) the capacity for air conditioning, and (6) whether comments were returned with the survey.

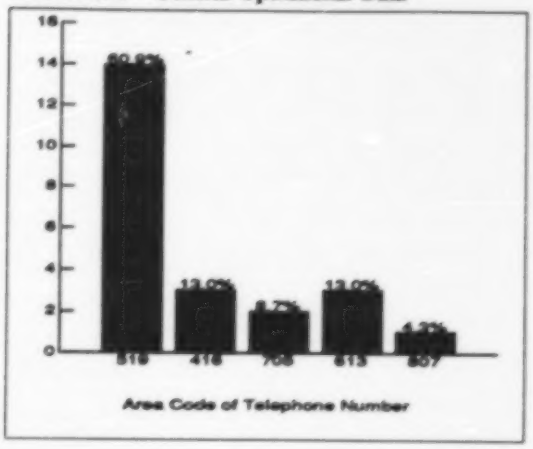
The second section is related to the potential of providing hot water and space heating from heat recovery technology. Six graphs illustrate: (1) the number of meat processors using heat recovery, (2) the energy source for heating hot water, (3) the capacity of the hot water tanks, (4) the volume of hot water used each day, (5) the energy source for space heating, and (6) the total refrigeration capacity.

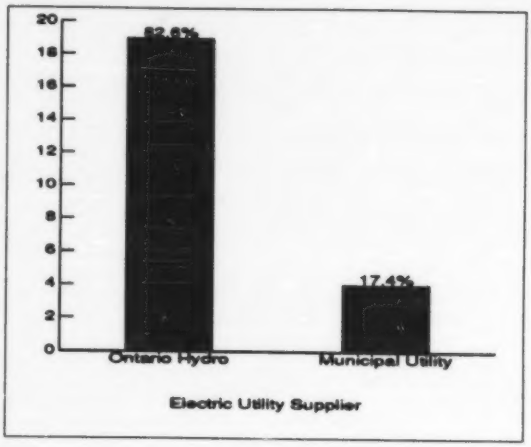
The third section describes the opportunities for efficient lighting. Three graphs show: (1) the number of hours that the light fixtures in the cold spaces are operating, (2) the number of light fixtures in the cold spaces, and (3) the average power demanded by each fixture.

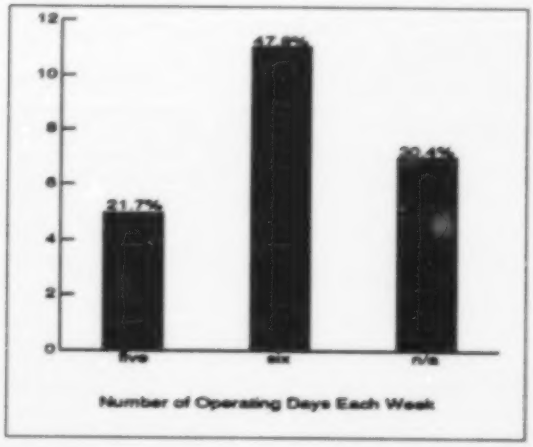
The fourth section illustrates the potential for electric stimulation of beef. It contains four graphs that display: (1) the number of meat processors using electric stimulation of beef, (2) the number of cattle processed each day, (3) the length of time that beef is aged inside the cooler, and (4) the percentage of packaged beef produced.

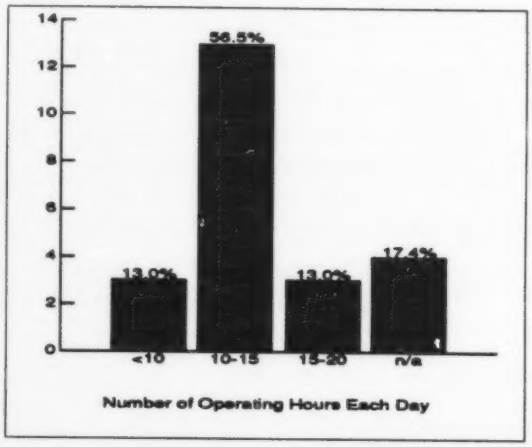
The final section provides information on processing of pork and chicken. The graphs show how many of each is processed each day, and how much is packaged.

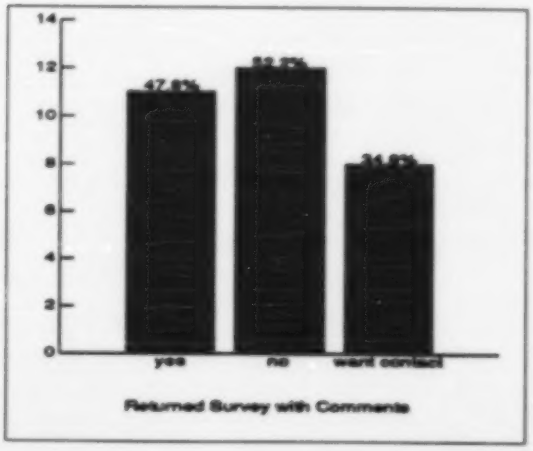
Section One - General Operational Data

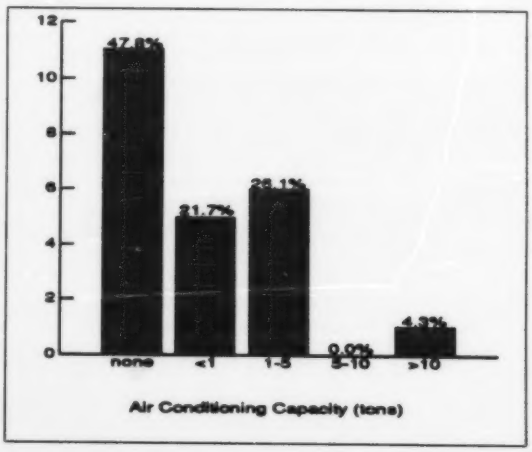




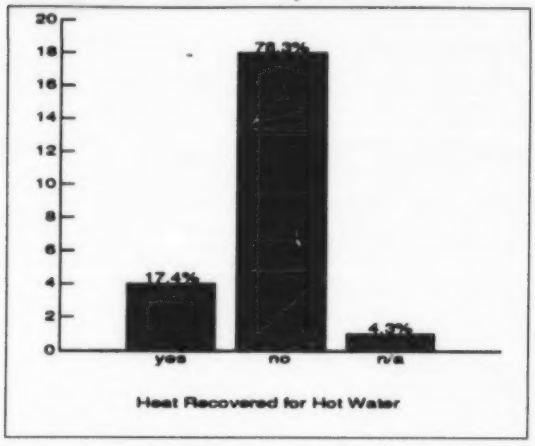


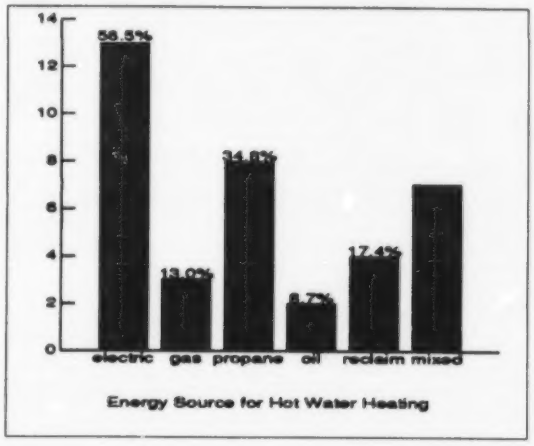


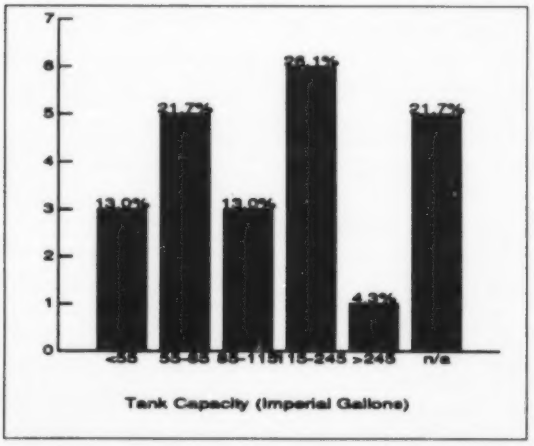


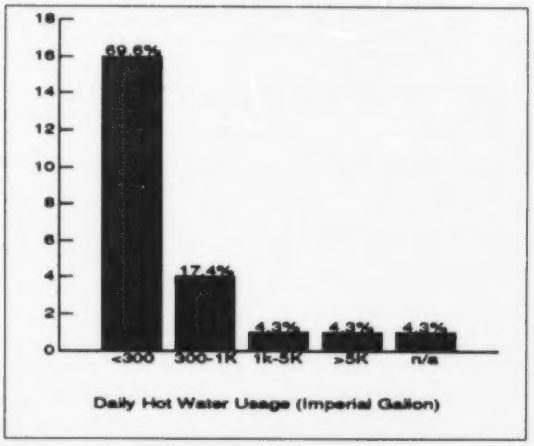


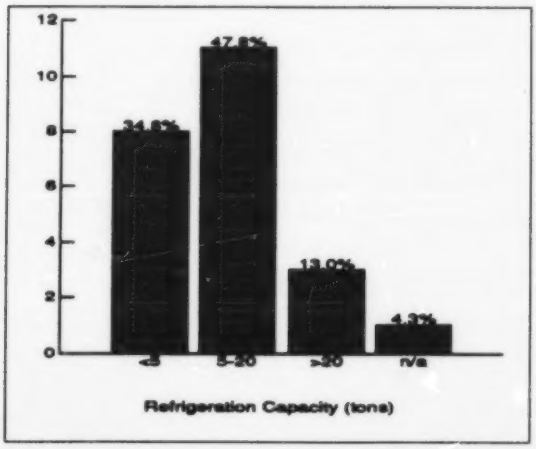
Section Two - Heat Recovery Potential

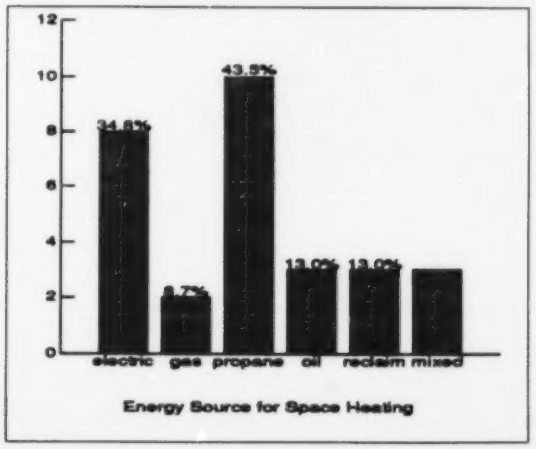


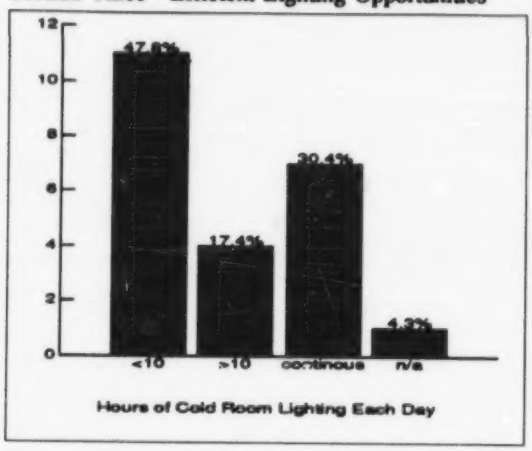








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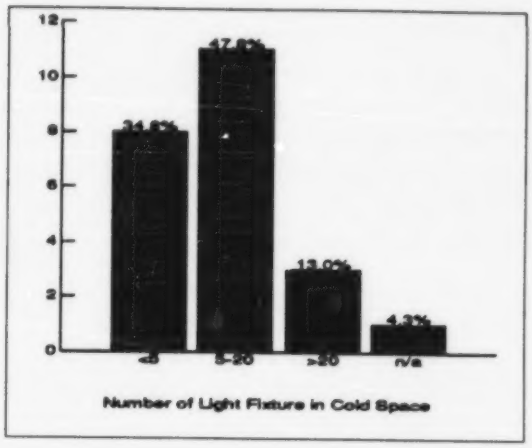
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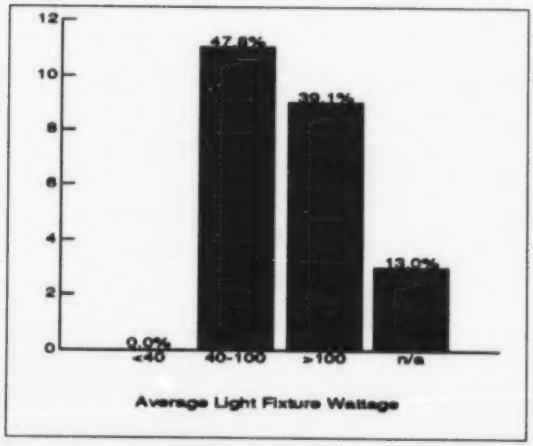
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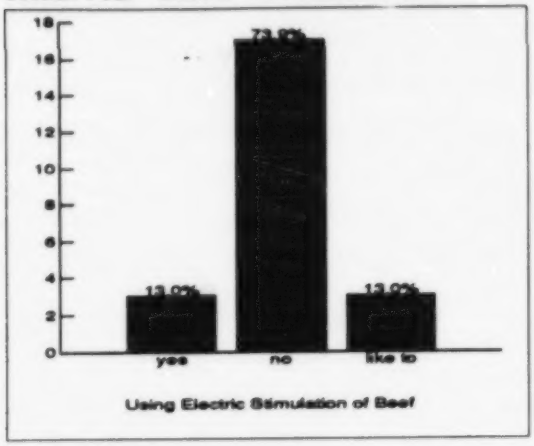
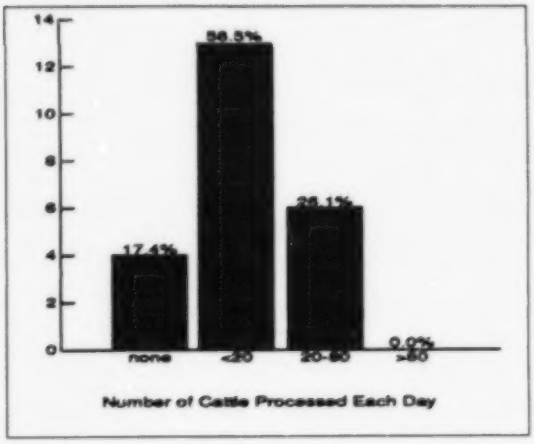
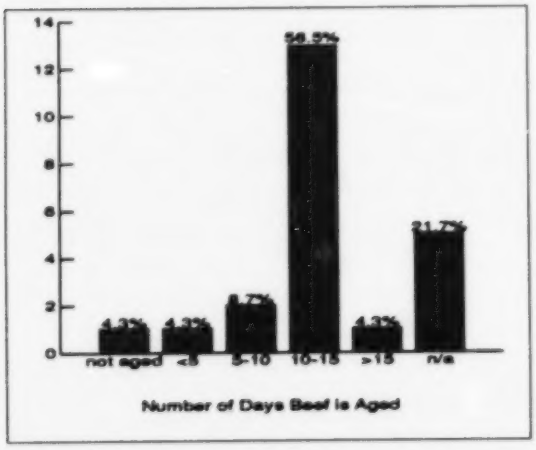
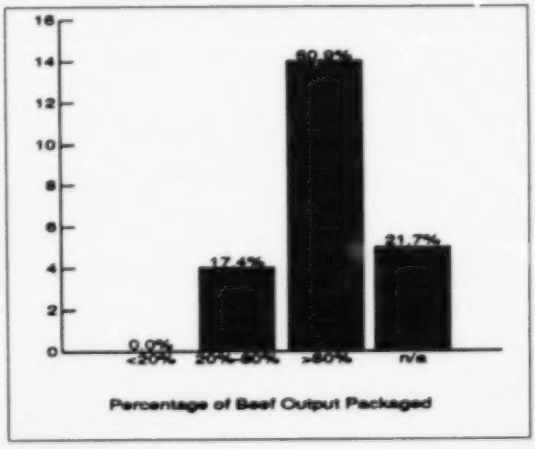
Average Light Fixture Wattage

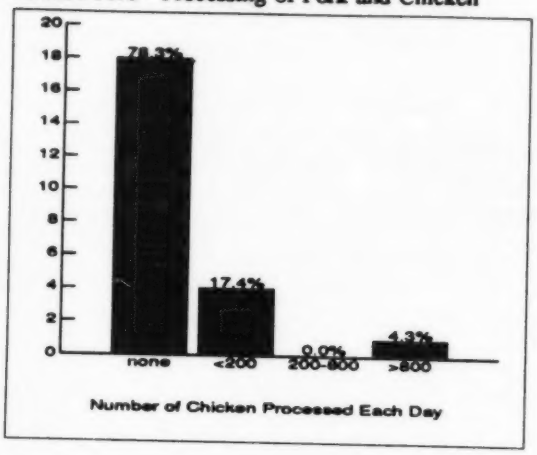
Section Four - Electric Stimulation of Beef

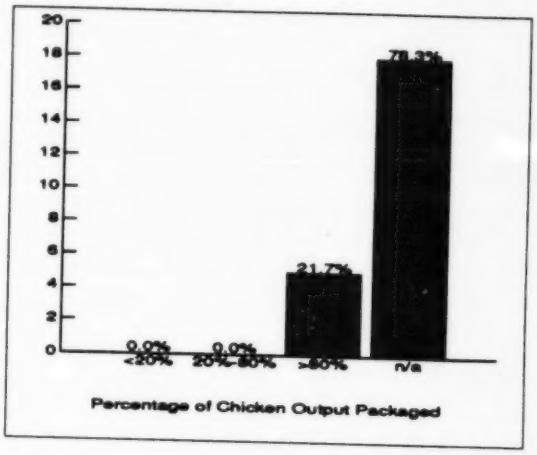


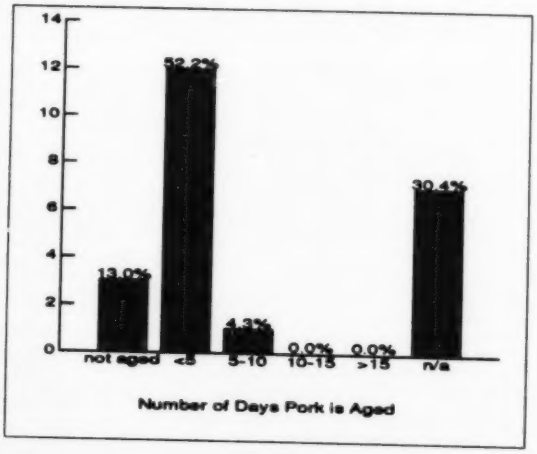


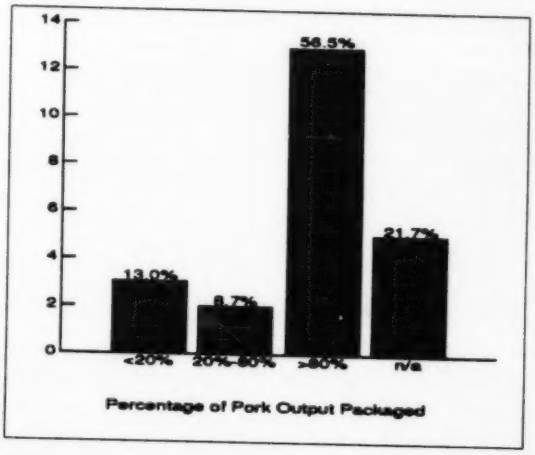


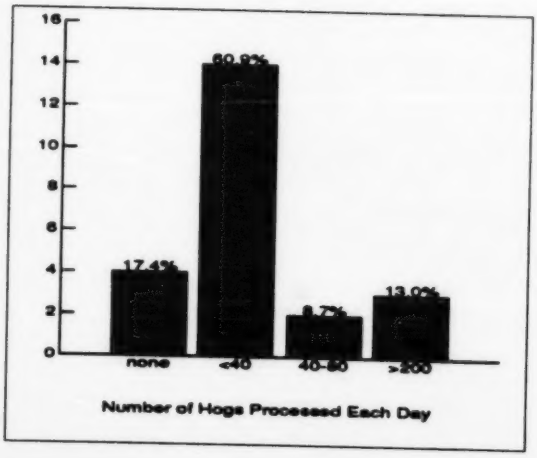



78.3%
17.4%
0.0%
4.3%
none
<200
200-800
>800
Number of Chicken Processed Each Day


78.3%
21.7%
0.0%
0.0%
<20%
20%-80%
>80%
n/a
Percentage of Chicken Output Packaged


13.0%
52.2%
4.3%
0.0%
0.0%
30.4%
not aged
<5
5-10
10-15
>15
n/a
Number of Days Pork is Aged


13.0%
8.7%
56.5%
21.7%
<20%
20%-80%
>80%
n/a
Percentage of Pork Output Packaged


17.4%
60.9%
8.7%
13.0%
none
<40
40-80
>200
Number of Hogs Processed Each Day

APPENDIX B. Meat Processing Industry Electricity End-Use Survey

Ontario Hydro is interested in finding energy efficiency improvement opportunities in the meat processing industry. Our objective is to help reduce energy consumption and thereby reduce electricity demand on Ontario Hydro's system.

Your participation in answering a few questions would help us gain a better understanding of your industry. Filling out the questionnaire requires from 10 to 15 minutes, by placing check marks in the appropriate boxes, or by circling the most applicable items. Space is also provided on the last page for your additional comments and suggestions. All individual responses will be kept confidential. After all the responses have been analyzed, a summary will be available to all the participants and the Society.

Your participation will allow us to answer the following questions accurately:

- How is electricity used in the industry?
- How much electricity is used for the different processes?
- What can improve productivity?
- What can reduce electrical consumption?

---

1 This question is *optional* but would allow our customer service representative to contact you in the future when there is further development.

Name _____
Title _____
Company _____
Address _____
City _____ Postal Code_____
Phone (____) _____
FAX (____) _____

2 Which *electric utility* supplies your power?

[__] Ontario Hydro area office _____
[__] municipal utilities Please specify _____
[__] private power company Please specify _____

3 What is the total *cooling capacity* of your *refrigeration system*?

[__] 5 tons or less
[__] 5 to 20 tons
[__] 20 to 50 tons
[__] more than 50 tons Please specify _____

4 Approximately, what is the number of animals that need *refrigeration* each day? (Please check all applicable options)

Cattle	[__] less than 20	[__] 20 to 80	[__] more than 80
Hog	[__] less than 40	[__] 40 to 80	[__] more than 200
Chicken	[__] less than 200	[__] 200 to 800	[__] more than 800
Other	[__] Please specify _____		

5 What is the total *holding capacity* of your cold room(s)?

Cattle	[__] less than 20	[__] 20 to 80	[__] more than 80
Hog	[__] less than 40	[__] 40 to 80	[__] more than 200
Chicken	[__] less than 200	[__] 200 to 800	[__] more than 800
Other	[__] Please specify _____		

6 How much *lighting* is there in the cold room(s)? (Please indicate the number of light bulbs and the wattage of the average light bulb.)

number of light bulbs
[__] less than 5
[__] 5 to 20
[__] more than 20

average light bulb wattage
[__] less than 40 W
[__] 40 W to 100 W
[__] more than 100 W

7 How many hours each day do the *lights* operate?

[__] less than 10 hours
[__] continuously

8 Are you *recovering rejected heat* from the refrigeration system to make hot water?

[__] Yes___
[__] No___

9 How much *hot water* is needed each day? (Please also select the unit of measurement.)

[__] less than 300
[__] 300 to 1000
[__] 1000 to 5000
[__] more than 5000

[__] Imp. Gallon
[__] U.S. Gallon
[__] Litre

10 What is the *hot water tank(s)* holding capacity?

_____ litres | U.S. gallons | Imp. gallons
(please circle one of above)

11 What energy source is used to make *hot water*? (Please check the applicable boxes)

[__] Electricity
[__] Natural Gas
[__] Propane
[__] Oil
[__] Other Please specify _____

12 What is used to provide *space heating* for the work area? (Please check the applicable boxes)

[__] Electricity
[__] Natural Gas
[__] Propane
[__] Oil
[__] Other Please specify _____

13 What is the cooling capacity of your *air conditioner(s)* for the work area? (Please check the applicable boxes)

[__] less than 1 ton
[__] 1 to 5 tons
[__] 5 - 10 tons
[__] more than 10 tons

14 If *lift trucks* are used to move heavy items, what is the energy source of the trucks? (Please check the applicable boxes)

[__] Electricity
[__] Natural Gas
[__] Propane
[__] Oil
[__] Other Please specify _____

15 What are your *operating* hours? (Please check all applicable options)

- [ ] 3-shift/day
- [ ] 2-shift/day
- [ ] 1-shift/day
- [ ] hours/day Please specify _____
- [ ] days/week Please specify _____

16 What are your *maintenance* hours? (Please check all applicable options)

- [ ] hours/day Please specify _____
- [ ] days/week Please specify _____
- [ ] weeks/year Please specify _____

17 What is *de-boned* on site? (Please check all applicable options)

- [ ] Beef
- [ ] Pork
- [ ] Chicken
- [ ] None of above

18 What is *aged* before shipping? (Please check all applicable options)

- [ ] Beef
- [ ] Pork
- [ ] Chicken
- [ ] None of above

19 If *aging* is done, How long is it kept in the cold room(s)? (Please check all applicable options)

Beef	[ ] not aged	Pork	[ ] not aged
	[ ] less than 5 days		[ ] less than 5 days
	[ ] 5 to 10 days		[ ] 5 to 10 days
	[ ] 10 to 15 days		[ ] 10 to 15 days
	[ ] Over 15 days		[ ] Over 15 days

20 What percentage is *packaged* before shipping? (Please check all applicable options)

Beef	[ ] less than 20%	[ ] 20% to 80%	[ ] more than 80%
Pork	[ ] less than 20%	[ ] 20% to 80%	[ ] more than 80%
Chicken	[ ] less than 20%	[ ] 20% to 80%	[ ] more than 80%
None of above			

21 Have you considered using *electric stimulation* of meat to either enhance aging or to allow hot de-boning of meat?

- [ ] yes, aging of beef
- [ ] yes, hot de-boning
- [ ] yes, both of above
- [ ] no, none of above

If the answer to question 21 is yes, please answer questions 22 to 25. Otherwise, please continue to the next page for your additional comments.

22 Can you discuss your reasons in deciding to use (or not to use) this technology?

_____

_____

23 Are you currently using *electrical stimulation* to enhance *aging* or for *hot de-boning*?

- [ ] Yes, to enhance aging
- [ ] Yes, for hot de-boning
- [ ] Yes, both
- [ ] No

24 What make of *electric stimulator* did you install?

_____

25 Does this technology meet your expectations? [ ] Yes [ ] No

Please use the space below for any comments or suggestions.

Thank you again for your participation.

Please return the completed questionnaire using the attached self-addressed envelop.

If you have any questions or comments, please feel free to contact either your Ontario Hydro customer service representative or:

Andrew Chow
800 Kipling Avenue, Room KR 263
Toronto, Ontario
M8Z 5S4
Tel. (416) 231-4111 ext. 6266
FAX. (416) 231-2585

APPENDIX C. Meat Processing Industry Electricity End-Use Survey Results

Area Code	519	416	705	613	807
	14	3	2	3	1
	61%	13%	9%	13%	4%

Utility	Ontario Hydro	Municipal Utility
	19	4
	83%	17%

Refri. tons	<5	5-20	20-50	>50	n/a
	3	12	5	2	1
	13%	52%	22%	9%	4%

Number Needing Refrigeration / Day

Cattle	none	<20	20-80	>80
	4	13	6	0
	17%	57%	26%	0%

Hog	none	<40	40-80	>200
	4	14	2	3
	17%	61%	9%	13%

Chicken	none	<200	200-800	>800
	18	4	0	1
	78%	17%	0%	4%

Other	6
	26%

Holding Capacity of Cold Rooms

Cattle	none	<20	20-80	>80
	4	5	14	0
	17%	22%	61%	0%

Hog	none	<40	40-80	>200
	4	8	8	3
	17%	35%	35%	13%

Chicken	none	<200	200-800	>800
	18	2	1	1
	82%	9%	5%	5%

Lighting in the Cold Spaces

number of bulbs	<5	5-20	>20	n/a
	8	11	3	1
	35%	48%	13%	4%

average watts	<40	40-100	>100	n/a
	0	11	9	3
	0%	48%	39%	13%

lighting hours	<10	>10	continuous	n/a
	11	4	7	1
	48%	17%	30%	4%

Heat Recovery Potential

HR for HW	yes	no	n/a
	4	18	1
	17%	78%	4%

HW use / day	<300	300-1K	1k-5K	>5K	n/a
	16	4	1	1	1
	70%	17%	4%	4%	4%

HW tank volume	**<55**	**55-85**	**85-115**	**115-245**	**>245**	**n/a**
	3	5	3	6	1	5
	13%	22%	13%	26%	4%	22%
HW source	**electric**	**gas**	**propane**	**oil**	**reclaim**	**mixed**
	13	3	8	2	4	7
	57%	13%	35%	9%	17%	
Space heating	**electric**	**gas**	**propane**	**oil**	**reclaim**	**mixed**
	8	2	10	3	3	3
	35%	9%	43%	13%	13%	
air cond. tons	**none**	**<1**	**1-5**	**5-10**	**>10**	
	11	5	6	0	1	
	48%	22%	26%	0%	4%	
lift truck fuel	**electric**	**gas**	**propane**	**oil**	**other**	**n/a**
	0	0	2	0	0	21
	0%	0%	9%	0%	0%	91%
Operating hours	**3-shift/d**	**2-shift/d**	**1-shift/d**			
	1	3	19			
	4%	13%	83%			
hours / day	**<10**	**10-15**	**15-20**	**n/a**		
	3	13	3	4		
	13%	57%	13%	17%		
days / week	**five**		**six**		**n/a**	
	5		11		7	
	22%		48%		30.4%	
de-boned on site	**Beef**	**Pork**	**Chicken**	**None**		
	19	20	3	1		
	83%	87%	13%	4%		
days Beef aged	**not aged**	**<5**	**5-10**	**10-15**	**>15**	**n/a**
	1	1	2	13	1	5
	4%	4%	9%	57%	4%	22%
days Pork aged	**not aged**	**<5**	**5-10**	**10-15**	**>15**	**n/a**
	3	12	1	0	0	7
	13%	52%	4%	0%	0%	30%
Beef Packaged	**<20%**	**20%-80%**	**>80%**	**n/a**		
	0	4	14	5		
	0%	17%	61%	22%		
Pork Packaged	**<20%**	**20%-80%**	**>80%**	**n/a**		
	3	2	13	5		
	13%	9%	57%	22%		
Chicken Packaged	**<20%**	**20%-80%**	**>80%**	**n/a**		
	0	0	5	18		
	0%	0%	22%	78%		
using el. st.	**yes**	**no**	**like to**			
	3	17	3			
	13%	74%	13%			
Comments	**yes**	**no**	**want contact**			
	11	12	8			
	48%	52%	35%			

APPENDIX D. Estimating Energy Efficiency Benefits

The following information is needed to estimate the potential electrical savings for a specific operation.

(a) number of operating days each year
(b) average temperature of cold water supply, °F
(c) volume of hot water use per day, imperial gallons
(d) number of hours per day that lights are on inside cold spaces
(e) number of light bulbs in the cold spaces
(f) average wattage of the light bulbs
(g) area of cold space, square feet

Table 1 shows the calculations for finding the energy savings specific to a given operation. Items (a), (b) and (c) in equation (A) are for estimating the savings due to recovering heat rejected by the refrigeration compressor to heat hot water. Similarly, equation (B) and items (a), (d), (e) and (f) can be used to find the savings from using efficient lighting.

Item (g) in equation (C) is for estimating the savings from improving the cold space insulation from R-20 to R-35. In order to simplify the calculations, it is assumed that the cold space is approximately square with a 10-ft (3-m) ceiling, and is about 2,500 ft^2 (232 m^2). Furthermore, the temperature difference between the inside and the outside of the cooler is assumed to be 60°F or 33°C. The refrigeration system is assumed to operate 24 hours each day, 365 days each year, with a coefficient of performance of 3. The full equation, which was used for calculating the data in the report, can be found following **Table 1**.

Finding the savings from electrical stimulation requires more detailed analysis that would be best done on an individual basis. However, a 50% reduction of refrigeration load due to reduced operating time is a conservative estimate. Equation (D) provides an estimate of the minimum reduction in electrical consumption using the same assumptions as for equation (C) and a cold space with R-20 insulation. Similarly, the full equation, which was used for calculating the data in the report, can be found following **Table 1**.

Table 1 - Estimating Energy Efficiency Benefits

(A) kWh/yr = **(a)** days/yr x (140 °F - **(b)** °F) x **(c)** imp.gal./day x 0.0028

(B) kWh/yr = **(d)** hr/day x **(e)** x **(f)** W x **(a)** days/yr x 0.001

(C) kWh/yr = **(g)** ft^2 x 3.1

(D) kWh/yr = **(g)** ft^2 x 3.6

Total (E) = (A) + (B) + (C) + (D)

The dollar value of the total savings is (E) multiplied by the electrical rate (ie: $0.06/kWh).

The following equations were used for calculating electrical load reduction due to improving insulation and due to electric stimulation of beef.

Improving the insulation reduces heat loss from the cold spaces and reduces refrigeration load. The heat loss can be estimated using the heat transfer equation. The refrigeration load reduction is approximately the heat loss divided by the refrigeration system's coefficient of performance.

$$\frac{kWh}{yr} = kW \times \frac{hr}{yr} = \frac{hr}{yr} \times \Delta T \times A \times \left(\frac{1}{R_{old}} - \frac{1}{R_{new}} \right) \times \frac{1}{3412\ Btuh} \times \frac{1}{COP}$$

where:

A = *ft² of total surface area*
ΔT = *temperature difference (oF)*
R_{old} = *old R-value*
R_{new} = *new R-value*
COP = *coefficeint of performance of the refrigeration system*

Using electric stimulation reduces refrigeration load by about 50%. This can be conservatively estimated by calculating the heat loss due to conduction through the walls. The energy consumption reduction is the refrigeration load reduction divided by the coefficient of performance of the refrigeration system. There are other factors which will add to the energy reduction. However, their complexity prevents further discussion at this time.

$$\frac{kWh}{yr} = kW \times \frac{hr}{yr} = \frac{hr}{yr} \times \frac{\Delta T \times A}{R} \times \frac{1}{3412\ Btuh} \times \frac{1}{COP} \times \zeta\%$$

where:

A = *ft² of total surface area*
ΔT = *temperature difference (oF)*
R = *R-value of insulation*
$\zeta\%$ = *percent of refrigeration load reduction*
COP = *coefficeint of performance of refrigeration system*